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OPERATION MANUAL
FOR
THERMAL VOLTAGE CONVERTER
P/N 84506

HOLT INSTRUMENT LABORATORIES

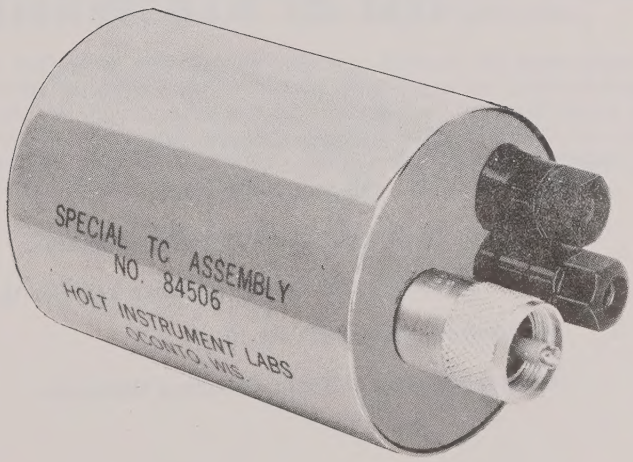
OPERATION MANUAL

FOR

THERMAL VOLTAGE CONVERTER

P/N 8450G

OPERATING AND SERVICING MANUAL FOR THERMAL VOLTAGE CONVERTER MODEL 84506



THIS MANUAL TO ACCOMPANY

INSTRUMENT NO - - - - - - - -

OCTOBER 1968

HOLT INSTRUMENT LABORATORIES

OCONTO, WISCONSIN

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CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested as soon as it is received. If it fails to operate properly, or it is damaged in any way, a claim should be filed with the carrier. Also, notify Holt Instrument Laboratories or the local representative immediately. A full report of the damage should be obtained by the claim agent and this report should be forwarded to us. We will advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

WARRANTY

Holt Instrument Laboratories warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory for that purpose and to replace any defective parts thereof. Electron tubes, fuses, and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid, and when upon our examination it is to our satisfaction defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify either the factory or the area Holt representative, giving full details of the difficulty, and include the model and serial numbers. Upon receipt of this information we will give you service data or shipping instructions.

2. On the receipt of shipping instructions, forward the instrument prepaid to the factory or the authorized repair station indicated in the instructions. If requested, an estimate of the charges will be made before the work begins if such work is not covered by warranty. All shipments of Holt Instrument Laboratories' equipment should be packed in a strong exterior container surrounded by two or three inches of shock absorbing material.

SECTION 1

INTRODUCTION

1.1 General Description

The P/N 84506 Thermal Voltage Converter is used to measure AC voltages in the audio and low radio frequency ranges with a high degree of accuracy. The performance is specified in the frequency range of DC to 50 kHz. Frequency response or accuracy readings are made by an AC-DC transfer technique, using an accurate, stable DC or low frequency AC source as the reference source.

The TVC operates over a voltage range of .5 to 1.1 volts, DC or RMS. The nominal input impedance is 140 ohms. The unit is capable of operating over a wide range of environmental conditions, as indicated under the technical specifications section.

The following definitions will be used in the manual. A thermoelement consists of a thermocouple and a heater, thermally connected by an insulating bead. These components are enclosed in a high vacuum glass envelope. The component parts will be referred to when appropriate to explain their functions.

TECHNICAL SPECIFICATIONS

INPUT VOLTAGE RANGE:	0.5 to 1.1 volt.
FREQUENCY RANGE:	DC and 5 Hz to 50 kHz.
AC-DC DIFFERENCE:	0.005% maximum to 10 kHz. 0.01% maximum to 20 kHz. 0.02% maximum to 50 kHz.
DC REVERSAL ERROR:	Less than 0.005%.
OUTPUT VOLTAGE:	8 millivolts minimum DC, open circuit, at nominal input of 1 volt.
INPUT RESISTANCE:	140 ohms ± 10 ohms.
OPERATIONAL ENVIRONMENT:	Above specifications will be met after thermally stabilizing under the following conditions: +4 to +40° C. Zero to 90% relative humidity. 0 to 10,000 ft. above sea level altitude.
MECHANICAL:	Enclosure size 2-9/16" Diameter x 3-5/8" Long. Terminals: 2 - 5 way binding posts - Output 1 male UHF-INPUT

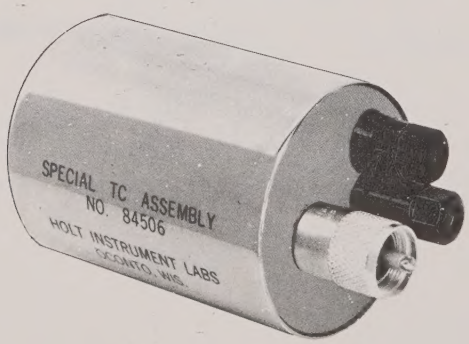


Figure 1. Thermal Voltage Converter P/N 84506

SECTION 2

OPERATING INSTRUCTIONS

2.1 Preparation for Use

a. The Thermal Voltage Converter is supplied as a completely self-contained unit. It requires no external power source. No adjustments or preliminary service is required before use.

2.2 Operation

There are three connectors on the unit. The input is a male uhf type connector for an applying input voltage. The output is obtained through two 5-way binding posts, one black and one red. There are no operating controls or adjustments.

The Thermal Voltage Converter is recommended for use as the transfer element in making AC to DC high-accuracy, transfer measurements. In this application it is important to observe care in connection to input voltage sources, ground and output measuring instruments. It is very important that the input common should never be allowed to be more than a few volts above or below the output common. Failure to do so may result in electrical breakdown of the glass bead which insulates the thermoelement heaters from the thermocouple. This would result in gross measurement errors. It is recommended that the input common be grounded at all times, exercising care to not create ground loops in connection to other instrumentation.

In making transfer measurements, it is recommended that the two voltage sources be connected to the TVC through a switch, allowing rapid transfer from one source to the other. This will prevent cooling of the heaters and subsequent loss of time to stabilize the output readings.

In operation, the input of the Thermal Voltage Converter is connected to a source of AC voltage of between 0.5 and 1.1 volts. The output will be measured by using a null detector and millivolt source. After a null is obtained with the AC voltage input, the input should be switched to a DC or low frequency AC source of the same voltage amplitude. Adjust the level of this source to reach a null on the null detector, without changing the setting of the millivolt source. The RMS value of the DC or low frequency AC input voltage is equal to the RMS value of the original AC input voltage to be measured.

Primary AC current shunts may be used with the Thermal Voltage Converter. The type HCS-1 shunts manufactured by Holt Instrument Laboratories are designed to have a nominal 1 volt drop at rated current. The accurate value of an AC current may be determined by transferring to a known DC current source.

CAUTION

The thermoelement in the TVC may be seriously damaged or destroyed by exceeding the 1.1 volt input voltage specification. Extreme care must be used to insure that this voltage limit is not exceeded.

Figure 2 shows a typical application of the TVC, checking AC-DC difference of an AC voltmeter.

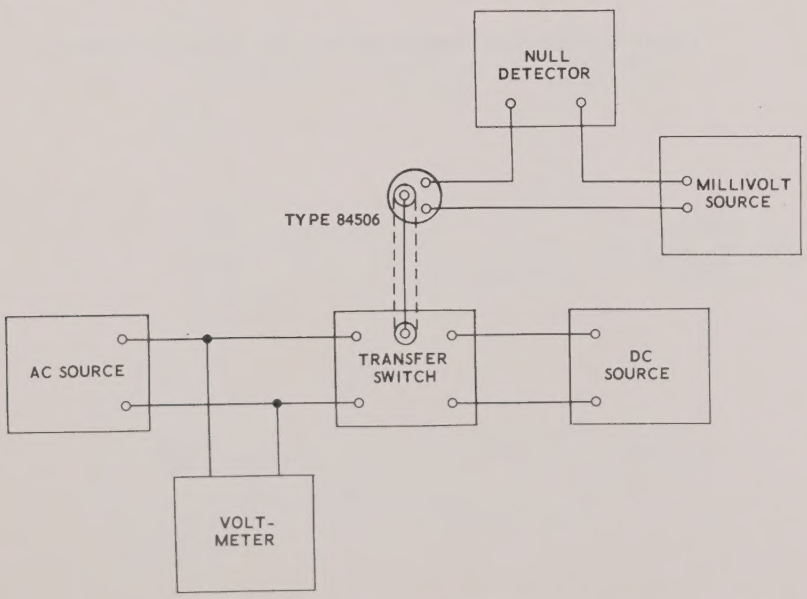


Figure 2. Typical AC-DC Transfer Test Set-up

SECTION 3

THEORY OF OPERATION

3.1 General Theory

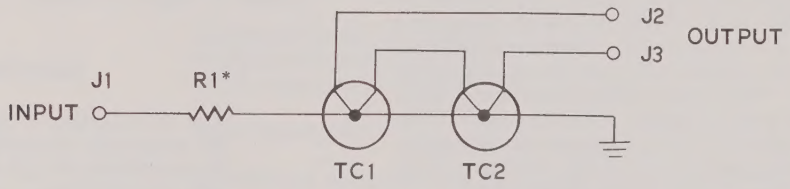
The fundamental theory upon which the type 84506 TVC is based is that the RMS value of an alternating current has exactly the same heating effect as a like value of direct current. Thus, if a thermocouple junction is heated with an unknown value of AC and the temperature of the junction is sensed, it is a relatively simple matter to reheat the same junction to precisely the same temperature with a DC voltage and accurately measure the value of the DC voltage. Based on this theory, the RMS value of the AC is identical to the value of the DC.

3.2 Basic Circuit Theory

The type 84506 consists of a simple circuit as shown in Figure 3.

The thermoelements are 7 milliampere type uhf units, with a nominal resistance of 45 ohms, and a nominal output of 7 millivolts DC, at the nominal input current. Two thermoelements are connected in series, selected to give a DC reversal error of less than .005%. R1 is selected to make the nominal input resistance 140 ohms.

The nominal DC output voltage is 14 mv at 1 volt input. Since the DC output is a square law function of the input voltage, the output will drop to 1/4 of 14 mv when the input voltage is reduced to 0.5 volts.



Factory Selected
* Nominal value 50 ohms

Figure 3. Schematic Diagram of Thermal Voltage Converter

SECTION 4

RECALIBRATION

4.1 Procedure

There is no recalibration needed since there is no compensation and there are no adjustments. The checks necessary are continuity, bead leakage, DC reversal error, AC-DC difference, input resistance, and output voltage.

Continuity checks should insure that no more than 7 milliamperes of ohmmeter current flows through either the heaters or thermocouples.

Bead leakage should be measured to insure a minimim of 50 megohms resistance between the heaters and the thermocouple, i.e., between J1 and J2 or J3. This measurement must be made with caution. Never apply more than 3 volts between heater and thermocouple. Larger voltages may break down the insulating bead.

AC-DC difference and DC reversal error must be checked in a standards laboratory having test facilities to insure compliance with the TVC specifications. The following test procedure is included to be used as a suggested method for evaluating the TVC. The equipment listed is of a quality sufficient to test to the TVC to assure that it performs properly. Other types may be substituted if equal in performance.

a. Input Voltage Range. Apply .5VDC to the input connector of the TVC. Measure the output voltage using a Fluke Model 883 differential voltmeter (or equivalent). Record the DC reading. Apply 1.0 VDC to the input connector of the TVC. Measure and record the output voltage.

Input	Output Limits
.5 V	3 MV Min. (3.5 MV Nominal)
1.0 V	8 MV Min. (14 MV Nominal)
1.1 V	15 MV Min. (17 MV Nominal)

b. AC-DC Difference and Frequency Range. Connect the TVC in a test configuration equivalent to Figure 4. Using the 400 Hz source, checked by the thermal transfer jig as the reference, check the frequency response at 10 kHz, 20 kHz and 50 kHz. The limits, referred to 400 Hz, are as follows:

Frequency	Limits
10 kHz	± .005%
20 kHz	± .01%
50 kHz	± .02%

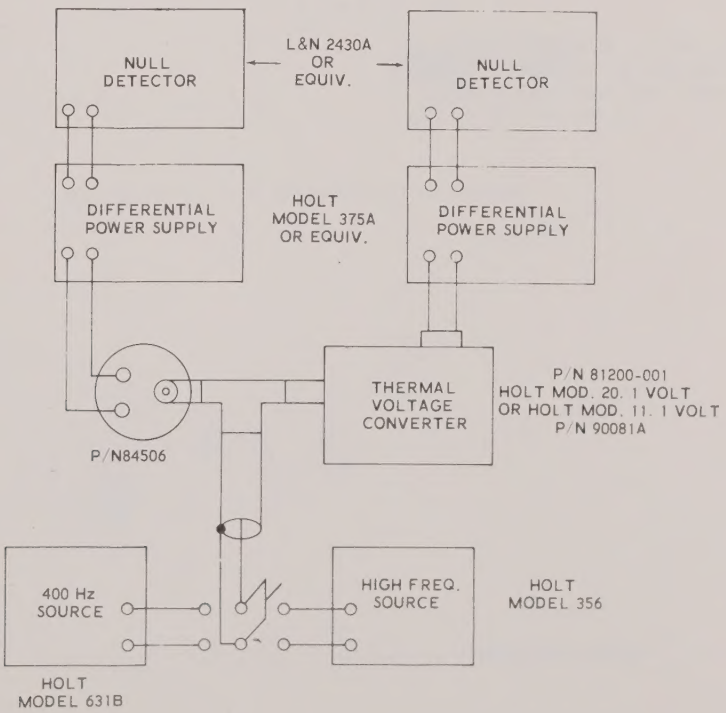


Figure 4. AC-DC Difference and Frequency Range Test Set-Up

c. DC Reversal Error. Connect the TVC in a test set up equivalent to Figure 5. Apply 1 VDC to the TVC. Null the galvonometer. Reverse the polarity of the DC voltage. Read the difference in the galvanometer reading. This is the DC reversal of the TVC. Calculate the DC reversal error by the formula:

$$\frac{\text{DC Reversal}}{2} = \text{DC Reversal Error}$$

The maximum DC reversal error allowed is .005%. Thus the maximum allowable DC reversal is .01%.

d. Input Resistance. Check the resistance from the center pin of the input connector to chassis, using a test which will not apply more than 1 VDC to the input. This resistance should be 140 ohms ± 10 ohms.

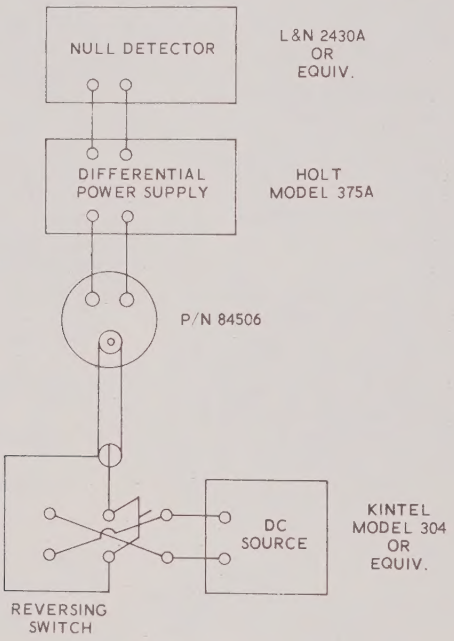


Figure 5. DC Reversal Error Test Set-Up

SECTION 5

SERVICING

5.1 Procedure

Service is limited to a simple procedure. The unit should be checked for mechanical defects. Inspect the terminals and connector for possible faults, i.e., loose mounting, etc. Service is limited to repairs on the external structure. Any attempt to open the TVC may result in destroying its certified performance. Therefore, any service which requires opening the TVC must be done in a laboratory equipped to test the unit to meet the electrical specifications of AC-DC difference and DC reversal error.

The heaters can be checked for resistance, using a method that insures the measuring current will be limited to 7 milliamperes. Use of an ohmmeter which will have a measuring voltage of more than 1 volt can damage the heaters. The resistance should be a nominal 140 ohms.

The output circuit of the TVC has a nominal resistance of 18 ohms. The same current limit should be observed when checking the resistance of the output circuit, limiting the current to 7 milliamperes.

Figure 6 is included to show the internal structure of the TVC.

SECTION 6

LIST OF REPLACEABLE PARTS

6.1 Replaceable Parts

No replaceable parts are listed in the manual, since replacing any component or terminal or repair of a connection inside the unit requires a thorough evaluation of specified performance. It is recommended that the units be returned to the manufacturer for repair.

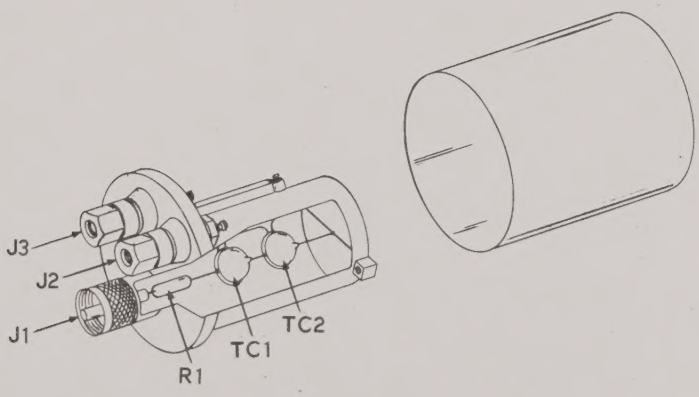
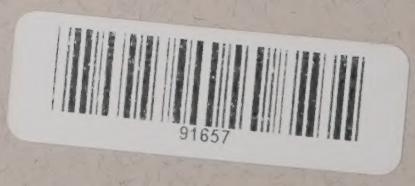


Figure 6. Internal Structure of Thermal Voltage Converter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